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PROPORTIONAL COUNTER FILLED WITH A MIXTURE OF XENON AND ISOPENTANE

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SUMMARY

In the present paper, parameters U and K, characterizing a gas, are computed for proportional counters filled with a mixture of xenon and isopentane. The influence of the space charge on the gas amplification parameter is studied for the case of γ-quantum energy. The relation $P_L / P_K \sim 1.1$ found, corroborates the data of [5], but departs sensibly from the earlier estimate in the work [6].

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In connection with the theory of operation of proportional counters [1, 2], the knowledge of two parameters, K and U, characterizing the gas, provides us with the possibility of computing the gas amplification factor (GAF) for any counter's geometry or operational regime. The given parameters are measured for various mixtures of argon and methane [1, 2].

In the present work parameters U and K are measured for a mixture of xenon and isopentane. The measurements were performed by the method described in [2]. The counter was filled with xenon (650 mm. Hg) and isopentane (10 mm. Hg); the diameter of counter's anode was 50μ, and that of the cathode 46 mm, the length being 274 mm. There was on the lateral surface of the conter a window 15μ thick and made of mica and aluminum.

Plotted in Fig.1 (next page) are the experimental results for α-particles with energy 5.07 Mev and γ-rays with energies 30.6 and 41.9 Mev (after passage of the window. The departure of experimental data from the straight line is due to the space charge.

(*) PROPORTSIONAL'NYY SCHETCHIK NAPOLNENNYY SMES'YU KSENONA I IZOPENTANA (Translation by special request).

As was to be anticipated, for particles with higher energy (α-particles) the action of the space charge is manifest for lower values of the GAF. Parameters K and U, determined by the data of Fig.1, are respectively K = 64.5 v/cm ·mm Hg; U = 23 v. It is interesting to note that parameter U only slightly exceeds the average energy required for the formation of one pair of ions (21.3 ev).

The data obtained allow us to determine the ionization cross section of xenon atoms by electrons, $\sigma = 3.2 \cdot 10^{-16}$ cm^2.

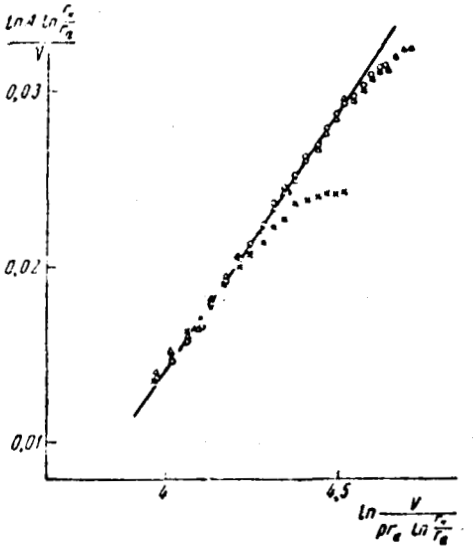

Fig.1. Determination of parameters K and U for the xenon counter. The crosses denote the results for α-particles (E = 5.07 Mev); the dots indicate the results for E_γ = 41.9 kev; the triangles — the results for E_γ = 30.6 kev

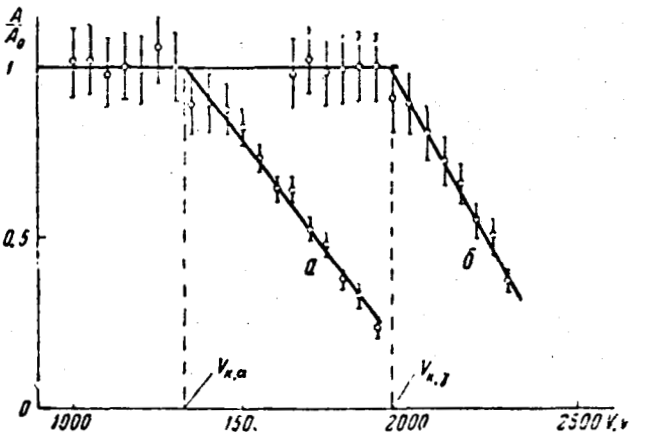

Fig.2. Dependence of the gas amplification factor (GAF) on voltage on the counter for : α-particles (a) (E = 5.07 Mev) and (σ) for γ-quanta (E = 30.6 kev) in relative units

Influence of the Space Charge on the GAF

The influence of the space charge on the GAF was investigated in the Pontecorvo work [3]. The author has shown that beginning from a certain value of the GAF (A_{cr}), the space charge leads to the deterioration of energetic resolution. It was shown that the product of the value of the GAF on the energy liberated in counter's operational volume is $A_{cr}E = 3 \cdot 10^8$ ev. Since the given condition has been obtained only for X-rays, it is of interest to determine it for another type of radiation. To that effect the dependence of GAF on voltage on the counter was taken down for γ-quanta (E = 30.6 kev) as well as for α-particles (E = 5.07 Mev). The results obtained are plotted in Fig.2. For α-particles the action of the space charge becomes manifest as of the voltage $V_{K,\alpha}$ = 1320 v, to which corresponds a GAF equal to 33.4. Hence we obtain $A_{cr}E_\gamma = 1.7 \cdot 10^8$ ev. For γ-rays with energy 30.6 kev $V_{K,\alpha}$ = 1950 v, to which corresponds GAF = 4910 and $A_{cr}E_\gamma = 1.5 \cdot 10^8$ ev.

The action of the space charge is manifest not only in the relative decrease of GAF, but also in the deterioration of the energetic resolution. Fig.3 shows the spectra of γ-quanta of Ba^{133} in the energy range 25–60 kev for 1900 and 200 volts on the counter. A significant increase in line 30.6 kev's $\frac{1}{2}$-width may be seen at V = 2000 v by comparison with V = 1900 v, the half-width being respectively 7.4 and 4.1 kev.

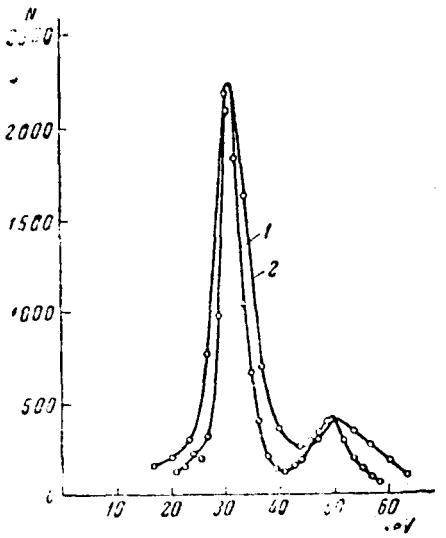

Fig.3. Energy spectra of γ-quanta of Ba^{133} in the energy range 25 to 60 kev, the voltage on the counter being 1900 v (1), 2000 v (2)

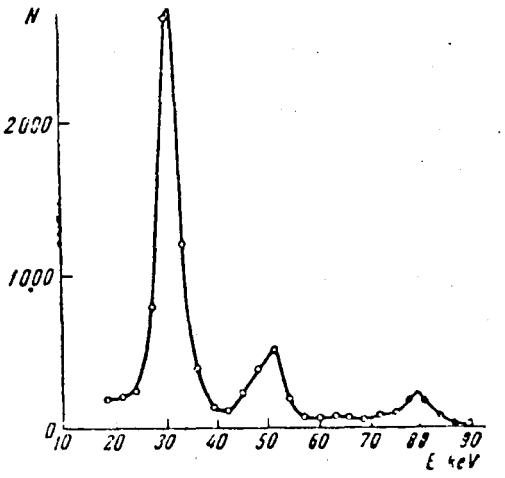

Fig.4. Energy spectrum of γ-rays of Ba^{133} in the energy range 30 to 80 kev. The voltage on the counter is 1300 v.

Spectrum of γ-rays in the energy range 30–80 kev

It is shown in Fig.4. The most intense line for 30.6 kev corresponds to X-rays of the daughter nucleus. The line E_γ = 78.6 kev corresponds to the relieving of excitation of daughter nucleus' first and second levels [4]. The observed broad peak in the region of 50 kev is conditioned by the superimposition of the "escape peak" from 78.6 kev to the line 53 - 56 kev in the spectrum of Ba^{133} [4]. From the obtained values of line intensities and with the utilization of data on the inversion factors of the different transitions [4], we could determine the relation $P_L / P_K \simeq 1.1$, where P_L and P_K are the probabilities of capture of orbital electron respectively from L- and K-shells. The value obtained agrees well with the data of work [5] but diverges from the earlier estimate $P_L / P_K = 9$ in the work [6].

**** THE END ****

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